WHAT IS CLAIMED IS:

1. A metal film wherein an arithmetic mean roughness of the surface is not larger than 2 nm and a (111) peak intensity of X-ray diffraction is not less than 20 times the sum of other peaks.

2. The metal film according to claim 1, wherein a difference in the reflectivity from a theoretical value of a pure metal is 0.2% or less in a visible light region.

3. The metal film according to claim 2, wherein variations in the reflectivity is 0.5% or less in a range of incident angles of light from 10 to 50°.

4. The metal film according to claim 1, wherein a difference in the reflectivity from a theoretical value of a pure metal is 0.2% or less in a range of wavelengths of light from 250 to 400 nm.

5. The metal film according to claim 1, which is made of at least a metal selected from the group consisting of Ag, Cu, Au, Pt, Al, Ti, Cr, Ni, Fe, W, Zn and Si.

6. A metal film-coated member comprising a substrate and the metal film of any one of claims 1 to 5 formed on the substrate.

7. The metal film-coated member according to claim 6, wherein an anti-reflection film comprising a plurality of dielectric material layers is formed on the surface of the metal film.

8. The metal film-coated member according to claim 6, wherein the substrate is made of glass, ceramics, semiconductor

material, metallic material or plastic.

9. A metal film formed by a thin film forming method of depositing a material of a thin film turned into plasma on the surface of a substrate that is maintained at a temperature not higher than 100℃, wherein an arithmetic mean roughness of the surface is 2 nm or less and a (111) peak intensity of X-ray diffraction is not less than 20 times the sum of other peaks.

10. The metal film according to claim 9, which is formed in the condition that a temperature of the substrate is not higher than 80℃.

11. The metal film according to claim 9, wherein a difference in the reflectivity from a theoretical value of a pure metal is 0.2% or less in a visible light region.

12. The metal film according to claim 11, wherein variations in the reflectivity is within 0.5% in a range of incident angles of light from 10 to 50°.

13. The metal film according to claim 9, wherein a difference in the reflectivity from a theoretical value of a pure metal is 0.2% or less in a range of wavelengths of light from 250 to 400 nm.

14. The metal film according to claim 9, which is made of at least a metal selected from the group consisting of Ag, Cu, Au, Pt, Al, Ti, Cr, Ni, Fe, W, Zn and Si.

15. A metal film formed by a thin film forming method comprising the steps of holding a substrate, over the surface of

which a thin film made of a metal is to be formed, in a chamber; supplying a gas for generating plasma into the chamber; applying high frequency electric field in the inner space of the chamber; heating and evaporating an evaporation material that is the material of the thin film, in the chamber; and controlling the gas supply wherein the quantity of the gas supplied into the chamber for generating plasma is controlled so as to be larger in the early stage of the thin film forming process than in the latter stage, wherein the substrate is maintained at a temperature not higher than 80℃ when the thin film is formed.

16. The metal film according to claim 15, wherein an arithmetic mean roughness of the surface is 2 nm or less and a (111) peak intensity of X-ray diffraction is not less than 20 times the sum of all other peaks.

17. The metal film according to claim 15, which is formed by the thin film forming method further comprising the step of applying a direct current voltage across the substrate and the boat that holds the evaporation material, with the boat serving as an anode.

18. The metal film according to claim 15, which is formed by the thin film forming method wherein the chamber is electrically floated.

19. An optical coating film comprising a metal film that has an arithmetic mean roughness of the surface being 2 nm or less and a (111) peak intensity of X-ray diffraction not less than 20

times the sum of other peaks, wherein a difference in the reflectivity from the theoretical value of the pure metal is 0.2% or less in the visible light region.

20. The optical coating film according to claim 19, wherein variations in the reflectivity is 0.5% or less in a range of incident angles of light from 10 to 50°.

21. An optical coating film comprising a metal film that has an arithmetic mean roughness of the surface being 2 nm or less and a (111) peak intensity of X-ray diffraction not less than 20 times the sum of other peaks, wherein a difference in the reflectivity from the theoretical value of the pure metal is 0.2% or less in a range of wavelengths of light from 250 to 400 nm.

22. The optical coating film according to claim 19 or 21, wherein the metal film is made of silver or aluminum.

23. A metal oxide film wherein a content of a non-oxidized metal is not higher than 1 mole % of a metal component that constitutes the metal oxide, and a packing density is 0.98 or higher.

24. The metal oxide film according to claim 23, wherein a difference in the reflectivity from a theoretical value is 0.2% or less in a visible light region.

25. The metal oxide film according to claim 23, wherein an insulation resistance is 1 GΩ or higher.

26. The metal oxide film according to claim 23, which is at least one selected from the group consisting of chromium oxide,

silicon oxide, titanium oxide, aluminum oxide, zirconium oxide, hafnium oxide and indium oxide.

27. A metal film-coated member comprising a substrate and the metal film of any one of claims 23 to 26 formed on the substrate.

28. The metal film-coated member according to claim 27, wherein the substrate is glass, ceramics, semiconductor material, metallic material or plastic.

29. The metal film-coated member according to claim 27, wherein the substrate is a resin film.

30. A metal oxide film formed by a thin film forming method of depositing a material of a thin film turned into plasma on the surface of a substrate that is maintained at a temperature not higher than 100℃, wherein a content of a non-oxidized metal is not higher than 1 mole % of a metal component that constitutes the metal oxide and a packing density is 0.98 or higher.

31. The metal film according to claim 30, which is formed in the condition that a temperature of the substrate is not higher than 60℃.

32. The metal film according to claim 30, wherein a difference in the reflectivity from a theoretical value is 0.2% or less in a visible light region.

33. The metal oxide film according to claim 30, wherein an insulation resistance is 1 GΩ or higher.

34. The metal oxide film according to claim 30, which is made of at least one selected from the group consisting of chromium

oxide, silicon oxide, titanium oxide, aluminum oxide, zirconium oxide, hafnium oxide and indium oxide.

35. A metal oxide film formed by a thin film forming method comprising the steps of holding the substrate over the surface of which a thin film made of a metal oxide is to be formed in a chamber; supplying a gas for generating plasma and oxygen gas into the chamber; applying high frequency electric field in the inner space of the chamber; heating and evaporating an evaporation material that is the material of the thin film in the chamber; and controlling the gas supply wherein the quantity of gas supplied into the chamber for generating plasma is controlled so as to be larger in the early stage of the thin film forming process than in the latter stage, while the substrate is maintained at a temperature of 60℃ or lower throughout the period when the thin film is formed.

36. The metal oxide film according to claim 35, wherein a content of a non-oxidized metal is not higher than 1 mole % of the metal component that constitutes the metal oxide and a packing density is 0.98 or higher.

37. The metal oxide film according to claim 35, which is formed by the thin film forming method further comprising the step of applying a direct current voltage across the substrate and the boat that holds the evaporation material, with the boat serving as an anode.

38. The metal oxide film according to claim 35, which is

formed by the thin film forming method wherein the chamber is electrically floated.

39. An optical coating film comprising a metal oxide film wherein the content of a non-oxidized metal is not higher than 1 mole % of the metal component which constitutes the metal oxide, and the packing density is 0.98 or higher, and a difference in reflectivity from the theoretical value is 0.2% or less in the visible light region.

40. The optical coating film according to claim 39, wherein the metal of the metal oxide film is at least one selected from the group consisting of the Group 3, Group 4, Group 5, Group 6, Group 13 and Group 14 in the Periodic Table.

41. An insulation film comprising a metal oxide film wherein content of a non-oxidized metal is not higher than 1 mole % of the metal component which constitutes the metal oxide, and the packing density is 0.98 or higher, and insulation resistance is 1 GΩ or higher.

42. The insulation film according to claim 41, wherein the metal oxide film is made of chromium oxide.

43. A thin film forming apparatus comprising:

a chamber wherein the thin film forming process is carried out;

a substrate holding means that is made of an electrically conductive material and holds the substrate, over the surface of which a thin film is to be formed, in the chamber;

a high frequency power source that supplies high frequency electric power to the substrate holding means;

an evaporation source that is formed in the chamber, and that has a boat for holding an evaporation material used as the material of the thin film, and a heating means for heating the boat;

a gas supply means that supplies a gas for generating plasma into the chamber; and

a gas supply control means that controls the quantity of the gas supplied by the gas supply means into the chamber so that the quantity of gas supply is larger in the early stage of the thin film forming process than in the latter stage.

44. The thin film forming apparatus according to claim 43, further comprising a vacuum level measuring means that measures the pressure in the chamber, while the gas supply control means controls the quantity of gas supplied by the gas supply means so that pressure in the chamber measured by the vacuum level measuring means is maintained at a predetermined level.

45. The thin film forming apparatus according to claim 44, wherein the predetermined value of pressure is in a range from 1.0×10^{-2} to 5.0×10^{-2} Pa.

46. The thin film forming apparatus according to claim 43, further comprising a DC voltage source that is connected between the substrate and the boat, with the boat serving as an anode.

47. The thin film forming apparatus according to claim 43,

wherein the chamber is electrically floated.

48. The thin film forming apparatus according to claim 43, wherein the chamber comprises an electrically conductive material.

49. A thin film forming method, which comprises the steps of:

holding a substrate, over the surface of which the thin film is to be formed, in the chamber;

supplying the gas for generating plasma into the chamber;

applying high frequency electric field in the inner space of the chamber;

heating and evaporating the evaporation material that is the material of the thin film in the chamber; and

controlling the gas supply wherein the quantity of gas supplied into the chamber is controlled so as to be larger in the early stage of the thin film forming process than in the latter stage.

50. The thin film forming method according to claim 49, wherein the gas supply control step controls the quantity of gas supplied by the gas supply means so that pressure in the chamber measured by the vacuum level measuring means is maintained at a predetermined level.

51. The thin film forming method according to claim 49, further comprising the step of applying a direct current voltage across the substrate and the boat that holds the evaporation

material, with the boat serving as an anode.

52. The thin film forming method according to claim 49, wherein the chamber comprises an electrically conductive material.

53. The thin film forming method according to claim 49, wherein the substrate is maintained at a temperature not higher than 100℃ when the thin film is formed on the substrate surface.

54. The thin film forming method according to claim 49, wherein the evaporation material is a metal, a metal oxide, a metal salt or a polymer compound.

55. A thin film forming apparatus comprising:

a chamber that is electrically floated wherein the thin film forming process is carried out;

a substrate holding means that is made of an electrically conductive material and holds the substrate, over the surface of which a thin film is to be formed, in the chamber;

a high frequency power source that supplies high frequency electric power to the substrate holding means;

an evaporation source that is formed in the chamber, and that has a boat for holding an evaporation material used as the material of the thin film, and a heating means for heating the boat;

a gas supply means that supplies the gas for generating plasma into the chamber; and

a DC voltage source that is connected between the substrate

and the boat, with the boat serving as an anode.

56. A thin film forming method, which comprises the steps of:

holding a substrate by a substrate holding means that is made of an electrically conductive material in the electrically conductive chamber that is electrically floated;

supplying high frequency electric power to the substrate holding means;

heating the boat that holds the evaporation material used as the material of the thin film, in the chamber;

supplying a gas for generating plasma into the chamber; and

applying a DC voltage between the substrate holding means and the boat, while using the boat as an anode.

57. A reflector mirror comprising, as a reflection layer, a silver film which has an arithmetic mean roughness of the surface being 3 nm or less and a (111) peak intensity of X-ray diffraction not less than 20 times the sum of other peaks.

58. An image projector apparatus, wherein the reflector mirror of claim 57 is provided.

59. The image projector according to claim 58, comprising a light source, a color separator for separating light from the light source into a plurality of chromatic lights, a light modulator for modulating each chromatic light separated by the color separator, a chromatic light synthesizer that synthesizes each chromatic light modulated by the light modulator to form

image light, and a projection lens that projects the light image from the chromatic light synthesizer onto a screen, wherein the reflector mirror is disposed in the optical path from the light source to the projection lens.